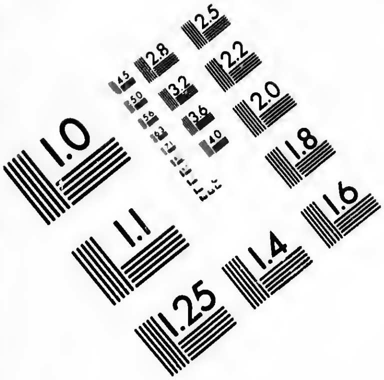

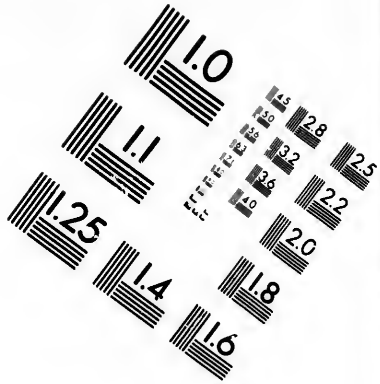

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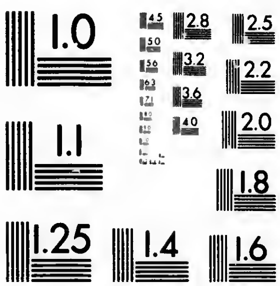

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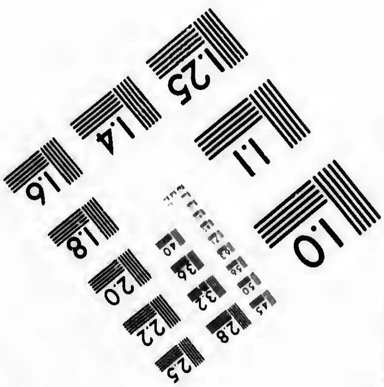

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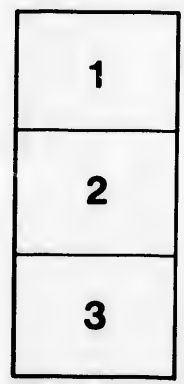

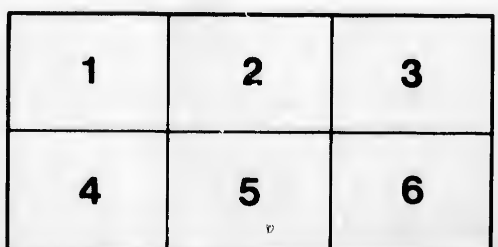

MEMOIR

UPON THE

Northern Inter-Oceanic Route

OF COMMERCIAL TRANSIT,

BETWEEN

Tide Water of Puget Sound of the Pacific

AND

Tide Water on the St. Lawrence Gulf of the Atlantic Ocean.

WRITTEN FOR AND READ BEFORE THE

BOARD OF TRADE, DETROIT, MICHIGAN.

By GENERAL T. J. CRAM,

U. S. CORPS OF ENGINEERS.

DETROIT: 1869

PUBLISHED BY THE BOARD OF TRADE.

PRINTED BY THE DETROIT DAILY POST.

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THROUGH Death's Door — the entrance of Green Bay into Lake Michigan — draw on the map a straight line bearing S. 82° W. to the Pacific Ocean.

By glancing at a recent map of the United States, the position of this dividing line will be fixed in the mind. It will be found to pass directly through St. Paul City, Minn.; thence rossing the Rocky Mountain ridge 15 miles south of the "South Pass;" thence through Ogden, Utah, 30 miles north of the great Mormon city; from Ogden, through Salt Lake, crossing the Sierra Nevada, 25 miles south of Carson City, Nevada; thence directly to San Francisco City, California. Such is the position of the first dividing line of the map.

Now, proceeding from the Door on this line only 130 miles to where it cuts the Wisconsin River, we shall there find ourselves equidistant over land from Lake Superior and Lake Michigan. But, as we advance toward the Pacific, every other point on the line is less distant from Lake Superior than from Lake Michigan; and before we reach even the Mississippi River the distance of the former is not one-half the distance from the latter lake; and every other point in our territory lying north of this line, as we proceed, is nearer to Lake Superior than to Lake Michigan; and so is much territory lying south of this first dividing line. For example, Sioux City, at the junction of the Big Sioux and Missouri Rivers, where Nebraska and Dakota corner upon the west boundary of Iowa, and being 200 miles south of our dividing line, is nearly 200 miles nearer to Lake Superior than to Lake Michigan.

To illustrate this striking inequality of distances in favor of Lake Superior to a fuller extent, draw a second dividing line from Death's Door, bearing S. 60° W. to the Pacific straight across the map. This crosses the Mississippi a short distance south of La Crosse, Wis., and thence passes directly through Omaha; thence 30 miles south of Santa Fee, crossing the Rio del Norte at Valentia, New Mexico; thence through San Pedro and Tubac of Arizona, and comes out at Angel Island, in the Gulf of California. This second dividing line contains the points of equal distances from the two great lakes—Superior and Michigan; and every point of all our territory lying north of it, even to the Pacific Ocean, is nearer to the head of Lake Superior than to the head of Lake Michigan. Geographically, therefore, of all our country west and southwest of the lakes—the Upper Peninsula of Michigan; one-half of Wisconsin; all of Minnesota; all of Dakota; all of Montana; all of Washington; one-third of Iowa; eight-tenths of Nebraska; all of Wyoming; all of Idaho; all of Oregon; one-third of Kansas; very nearly all of Colorado; all of Utah; all of Nevada; all of California; three-fifths of New Mexico, and nine-tenths of Arizona, are situated nearer to the head of Lake Superior than to the head of Lake Michigan. And in proportion as we go north of this second dividing line into these States and Territories, does the distance become farther from Lake Michigan and nearer to Lake Superior.

But to return to the north of our first dividing line, into what may be strictly regarded as the "Northwest" of the United States. No one who will take pains to study its map, topography of its States, Territories and towns, its minerals, forests, soils and relative climate as shown by the isothermal lines, can fail to perceive that this "Northwest," containing 870,776 square miles, must, in time near at hand, have an important *weight* in respect to political, productive, and commercial interests.

It has been demonstrated that the Rocky Mountain, the Sierra Nevada and Cascade Ranges, traversing this Northwest, have passes of comparatively low elevation, through which the iron links of railways will chain all its States into one continuous sisterhood of inter-commercial connexion.

There are in this Northwest portion of the United States, five hundred and sixty millions of acres, upon a large portion of which railways, when constructed, will soon impress the prosperity, wealth and power now possessed by such States as Michigan, Ohio, Indiana and Illinois.

This Northwest contains the winter wheat region of this continent. It is richly supplied with coal, iron, gold, lead, silver, and copper, with forests and prairies, with good building stone, an abundance of water, and with an immensity of water power. The salubrity of its climate is remarkable. It is favored with a temperature so mild that cattle range and fatten on its grasses through the winter as high even to within a few miles of Cadott's Pass of the Rocky Mountain range.

In its valleys, all kinds of fruit incident to a northern temperate climate grow to maturity. Its vast feeding grounds afford a home summer and winter for the buffalo, the elk, and the antelope, which is evidence of the excellence of its climate and the quality of its native grasses.

In short, almost every element of wealth, every requisite condition of social growth and prosperity for man, naturally and so abundantly exists in this region of country as to be sufficient, after deducting all waste land, for the well being of at least twenty millions of civilized christian people.

The questions arise: How is this Northwest to be filled up? and how are its dormant elements of wealth to be utilized?

It is no new axiom, that "without roads there can be no decent society, no government, commerce or intelligence." Works constructed by the Romans and Peruvians—some of which still stand and challenge the abmiration of Engineers,—fully attest that those people well understood the force of this axiom.

And there is another truth which I need not stop to demonstrate, but will quote: "That in proportion to the number and excellence of artificial highways, and the improvement of natural channels of communication, are the exchange of services between men, the intercommunication of thought, the economy and productiveness of labor, the increase of wealth, the growth of comfort, and the development and consolidation of the civilized state."

Now, the greatest, cheapest, most effectual and most natural means for providing for, and visiting all these benefits upon our "Northwest," are,—

I. THE IMMEDIATE CONSTRUCTION OF THE PROPOSED NORTHERN PACIFIC RAILROAD.

The act of Congress donating lands for this prescribes that it shall be laid north of the 45th Parallel of North Latitude. Its termini are at Seattle, on Puget Sound, and a point, not yet designated, at the head of Lake Superior. The same act authorizes the company to construct a branch from where the main line cuts the Columbia River, down said river to the City of Portland, Oregon. It also gives the right to the company for constructing another road from Portland to Seattle, but for this latter no lands, except the right of way, are donated.

The main line is to run through Minnesota, Dakota, Montana, Idaho and Washington, and the branch through Oregon, thus accommodating six States directly. It crosses the Rocky Mountain Range at Cadott's Pass, and the Cascade Range at Snoqualime Pass.

To enable the company to construct it, Congress has donated from the public domain, for 232 miles, which will be in Minnesota, a strip 10 miles wide on each side, making 20 square miles, or 20 sections, to each lineal mile of this part, and for all the remaining 1,543 miles of the line, 20 square miles on each side, making 40 square miles to each lineal mile of this part of the road.

The length of the road is estimated to be 1,775 miles between the head of Lake Superior and Puget Sound. The total amount of land donated, and to be selected by the company, is 66,360 square miles, or 42,470,400 acres, which, valued at only $2.50 per acre, gives the company a starting basis to hire money upon of $59,817 per lineal mile of road. The comparative cheapness with which this road can be constructed under proper management, is strikingly apparent, by simply stating a few facts. Its route is cut by rivers, already navigated by steamboats from their several mouths, up to the very points of intersection by the road. These rivers divide the line into seven sections, at both extremities of each of which the work of construction could commence simultaneously; and all supplies, materials, tools, and workmen, can be readily deposited by the river navigation upon the line, at the extremities of the sections. Throughout the whole line the climate is healthy for men to labor in. On the route there exist good stone and wood, as a general rule, within convenient distance for its construction, and near to the eastern terminus all the iron exists for making the rails of the very best quality, and a ship navigation from the rolling mills which will soon be in operation at Marquette, Michigan, to the very eastern terminus of the road. These are circumstances of great weight, tending to lessen, very materially, the cost of construction, and furnish peculiar advantages to this extensive route. Indeed, it would seem as if the bountiful hand of Providence had provided with special foresight for the accomplishment of this great design.

Besides the six States mentioned which will be put in direct communication with each other, and with the whole East, by the construction of the Northern Pacific Railroad, there is just about an equal area of good country on the North in British America, embracing the Frazer, Saskatchawan, Assiniboin, and Red River valleys, which would also be accommodated by it with a favorable communication with the East, and it would serve as the leading means for peopling those valleys, from which, in due time, the travel and traffic would be found to be a fruitful source of revenue to the road.

But there is another and more immediate source of revenue that the company may count on for their road, to be derived from military operations.

Between Minnesota and Washington on the route, and along on the north in the British territory, and on the south in our own, there are countless tribes of Indians. Just as fast as the construction of the road would progress, people from every land would pour in. In a short time from their advent, the cupidity and hostility of the red men would be roused, and history repeating itself, Indian wars in all that region would commence, and our government would be obliged to commence and for some time continue military operations to put down depredations, requiring a vast amount of transportation on the road, and after quelling hostilities the military posts that would be maintained to keep the peace, would be supplied, in a great measure, over the road, yielding a corresponding revenue.

Our Northwest must not only depend upon this road for becoming fully peopled, but it must, with other roads that will connect with it, and some of which are now being built, be the means of outlet to connect its future commerce with the East by ship navigation, at Lake Superior; and this will, as a consequence, greatly enlarge the business through the lakes and their connecting rivers, whose necessary improvements to meet this growing demand of commerce will now be considered.

II. IMPROVEMENTS FOR A SHIP NAVIGATION FOR LARGE VESSELS FROM THE HEAD OF LAKE SUPERIOR TO THE MOUTH OF THE ST. LAWRENCE RIVER.

1. Wherever the final terminus of the Northern Pacific Railroad is made at Lake Superior, the point must be where a good and safe harbor for shipping can be made at all times having not less than sixteen feet.

If Superior City be made the terminns, the *harbor* and *docks* will probably cost about $750,000. If Ashland or Bayfield be the ultimate terminus, the cost would be very much less — we may say little or nothing, except for docks. But a terminus at either of these last two named places would necessitate an additional extent of 50 to 60 miles of railway construction into Wisconsin. To permanently rest the terminus at DuLuth, Minnesota, will require an expenditure of about $1,000,000 for the construction of a safe harbor, enclosed by ample breakwaters, and for the requisite docks.

The relative cost of the harbor constructions, compared with the cost of extending the road to Ashland, will, in a measure, solve the problem of the final terminus upon Lake Superior.

The next improvement in descending will be the St. Mary's Canal, which is at a point in St. Mary's River a few miles below the lower end of Lake Superior, where there are two single locks of 70×350 feet chambers and 9 feet lifts. It is well-known that this Canal was built by the State of Michigan from the proceeds of public lands donated by the United States. It is under State control. Since its construction, the commerce of

Lake Superior has augmented so much as already to require the capacity of the Canal to be proportionately increased. With a view of having it improved by the General Government, the Legislature of Michigan passed a law ceding it to the United States, and thus, it is obvious, the first step has been taken in the accomplishing of this object.

This Canal cannot be made to answer the present and future demands of the commerce short of the following items of improvement, viz: Deepen the existing locks to give 16 feet of water on the mitre sill—there is now, at low stage of navigation, only $10\frac{5}{8}$ feet; deepen the Canal to 17 feet, and make its rough, rocky, sloping sides vertical; prolong the upper end of the north bank of the Canal to enable vessels coming down to more safely enter, and construct another lock with chamber 350×50 feet, overcoming the fall with one lift along side the present locks. The expense of these improvements cannot be given with much certainty until an examination and survey be made with a view of making an estimate. The cost will not be less, I venture to say, than $250,000. All can be done, however, without injury to the present locks, or any destruction of existing works, except the old gates, mitre-sills, and some of the old grillage; and what is of great importance, the improvements can be accomplished in intervals between the closing and opening of navigation, and thus without interfering with the passage of vessels through the Canal. There are other places besides the Canal in this river requiring attention, and which have been recently surveyed in a special manner under the orders of the United States Government, for the purpose of planing for and estimating the costs of their improvement, viz: Boulder rocks, three at a place above and three at places below the Canal, to be removed; the west, or American channel of the East Neebish Rapids to be widened and straightened; the channel at the head of Rains' Island to be straightened and widened; ehannel at the foot of Sugar Island to be straightened and widened; and a little more widening to be done on one side at the foot of the new middle channel through Lake George, for an extent of only 300 feet, left undone because of the funds falling short by about $8,000. All these five improvements will cost $149,021; and when they are made, vessels can safely pass each other in them, and the river be safely navigated throughout in the darkness of night. At present, they do not attempt night running, when dark, and consequently much detention ensues.

Still descending, there is no place in Lake Huron, nor in St. Clair River, requiring improvement, until we come to the St. Clair Flats obstruction, where this river debouches into Lake St. Clair. This obstruction is now being improved upon a grand scale by the United States Government, with a new Ship Canal, straight from deep water of the lower reach of the river into deep water of the lake. The Canal is 300 feet wide, 14 feet deep, with dikes rivetted on each side, rising five feet above water and to a thickness of 40 feet on top. It will be completed and opened for vessels in the summer of 1870. It is without lock at foot or guard gate at head, and so constructed that it can be deepened at any time to 16 or 20 feet, at an additional cost of thirty to fifty thousand dollars, without in the least endangering the stability of the dikes. Its length is about 1½ mile; and total cost will be $425,000 at most; all of the funds, into $15,000, have been appropriated by Congress for its completion.

Descending from this important Canal through Lake St. Clair, thence through Detroit River into Lake Erie, and through this lake into the Niagara River below Buffalo to Schlosser, there is no obstruction to the largest draft of ship navigation on these inland seas, until we come to the Niagara River rapids and its stupendous Falls. Around this obstruction there exists, on the Canada side, the well-known Welland Canal, 28 miles in length, leaving Lake Erie at Port Colborne, 18 miles west of Buffalo, and debouching into Lake Ontario at Port Dalhousie, avoiding not only the Falls, but all the Niagara River, thus throwing aside the parts above and below the Falls which are eminently susceptible of deep navigation, and overcoming the total fall from the head to the foot of the Canal of 334¼ feet, with 27 locks of 150×26½ feet of chamber and only 10½ feet water on the mitre sills.

This total of 334¼ feet is to be regarded as the difference of level between Lake Erie, at Port Colborne, and Lake Ontario, at Port Dalhousie. Subtracting the perpendicular descent of the Niagara Falls from this, the remainder would be the fall of the parts of the river which are above and below this cataract. It is not necessary to go into a complete history of the construction of this important work. At the time of its projection it was thought it would have capacity enough. It only admits in its maximum capacity vessels 140 feet long and 26 feet beam, drawing 10½ feet, and of 500 tons burthen, equivalent only to 16,667 bushels of wheat.

It is apparent to those familiar with the present size of vessels — of which there are quite a number engaged in lake commerce little short of 300 feet in length, including bowsprit — and to those appreciating the rapid growth in future, that to fully meet the wants of this commerce by the Welland Canal, it would have to be greatly enlarged.

Cheap freight is what is required for the exports and imports of the Northwest, and the whole lake country, whether on the Canada or American side.

This desideratum can be attained in a great degree by having vessels of larger capacity and providing for their passing the obstructions by a well devised and well executed system of improvements. The expense of labor for navigating a vessel carrying fifty thousand bushels of wheat would be only eight dollars per day more than for navigating one carrying only 25,000 bushels. Experience in lake navigation has shown this statement to be true. A certain way, then, to cheapen freight, is to enlarge existing canals and deepen correspondingly the natural channels where obstructed.

To meet the question upon this policy squarely in the face, the Welland Canal should have its locks enlarged to chambers of 350×50 feet, and 16 feet of water on the mitre sills; and the water ways everywhere between the locks in earth cutting or embankment to a width of 90 feet at bottom and 140 feet at water surface, and to 100 feet in width with sides vertical in rock cutting, and to a depth of at least 17 feet. This would be on a scale of no greater capacity than proposed for the ultimate improvement of the Sault de St. Marie Canal, and St. Clair flats.

But there is a very serious natural obstacle to improving the Welland Canal to such capacity, and which is only known to the initiated few, and I feel it a duty to commerce to state that I have it from an undoubted source, that in the lake in front of

Port Colborne, which is at the head of this canal, there is a wide extent of rock formation, coming up within 12 feet of the surface of the lake; its width is at least 1,000 feet, and perhaps more. Without excavating a channel through this rock, which, owing to exposure to gales, would cost several millions, it would be useless to deepen the canal to more than 12 feet of water on the mitre sills.

I am not aware of any minute survey having been made of this extensive formation under the lake water. The character of the rock is of the hardest kind, well known as the Black Rock lime stone.

The enlargement of this canal, with locks 250×40 feet of chambers, and 12 feet draft on the mitre sills, has been estimated to cost $5,000,000 in gold.

To enlarge it to the full capacity demanded, and to blast a corresponding channel through the lake rock, which shall give at all times of fluctuations of the height of water in the lake, 17 feet of water, would probably cost from ten to twelve millions of dollars.

The great expense of such an improvement, the length of time required to make it, the length of the canal, its being in a foreign country, and the tolls being independent of any regulation by our own government, are points of objection of sufficient weight to induce the construction of a shorter and better Ship Canal around Niagara Falls on the American side.

This is of so much importance to our Northwest, that I here take occasion to enter somewhat extensively into a review of this question, with a view of explaining its most important engineering points.

This is no new project. More than 60 years ago, during Mr. Jefferson's administration, a company was formed under a grant from the State of New York to make this Canal. But it lingered; the Erie Canal project being in process of execution, throwing the project for one around the Falls in the shade, though not into perfect oblivion, until the next year (1826), after the opening of the Erie Canal, when a survey was made for the Falls Canal, at private expense, during the administration of John Quincy Adams. Upon this survey, the project again slept until 1835, during General Jackson's administration, when, by authority of Congress, a more perfect survey and plans and estimates were made by Captain Williams, Corps of Topographical Engineers. But, to the disappointment of its friends, the project was again doomed to slumber through all succeeding administrations until Mr. Lincoln's first term, when the military spirit was aroused by the rebellion, and public opinion looked with feverish anxiety to the military necessity of the Canal. Under authority of Congress, a report and estimates were made by a civil engineer, appointed by President Lincoln, for the construction of the work. Since that time tedious discussions have been held, in and out of Congress, as to whether it should be constructed by a company, aided by funds from the public treasury, or by the General Government alone, resulting, however, only in another survey being ordered by Congress in 1867, during the administration of President Johnson. In these discussions the project has lagged from the want of sufficient support for directing its construction by Congress, on the ground that it ought not to be constructed by the United States, unless with the previous consent of the State of New York, and that it would diminish the revenue of that State derived by the use of the Erie Canal for moving the exports of the Lake and Northwestern States to the seaboard. These are the only objections I have ever heard against its construction.

And now (in 1869), how stands the question of this contemplated Canal?

After the long period of sixty years or more since its importance was first publicly agitated, and during which the spasmodic efforts alluded to have been occasionally manifested, this great national design reposes upon the last survey made in 1867, under the direction of Colonel Blunt, Corps of Engineers, and is no more of a realization than it was at the first survey in 1808, when the work was not needed the one-hundredth part as much as at the present time.

If our Northwest intends it shall be completed, and I doubt not its loud demands will force its construction, either by private or public means, as soon as the consequences of the gigantic consolidations of railroads become developed in their relation to the transportation of products, it is desirable for all interested in the work to have the Canal not only located on the best route, but also to have it constructed upon a plan commensurate with all future commerce that may reasonably be expected to flow between the Pacific and Atlantic along the route of the projected Northern Pacific Railroad and the chain of Lakes.

In regard to location, all other things being equal, the shortest of the practicable lines should be adopted. The shortest leaves Niagara River at Schlosser (3 miles above the Falls), and debouches into this River, below the Falls and all the rapids, at a point 700 feet north of the steamboat landing at Lewiston, N. Y., being $7\frac{6}{100}$ miles long, which is only one-fourth the length of the Welland Canal. The profile on this route gives the total fall between the Schlosser and Lewiston termini 316 feet, and the horizontal distance between the head of the upper lock of Colonel Blunt's plan and the river, 8,071 feet. In this space he proposes 21 double locks (20 of 15 and 1 of 16 feet lift) to pass the total fall, and distributes the locks in 5 flights, separated by some short basins, and there is to be a guard lock and harbor construction at Schlosser; the locks to be only 46 × 250 feet in chamber, with only 14 feet water on the mitre sill, and only the same depth (14 feet) in the Canal and basins. Such locks would not admit vessels drawing more than 13½ feet, nor of length more than 245 feet, and 45 feet beam. A heavy vessel of that draft would tow prodigiously hard, and with snail progress with only 6 inches of water under her keel.

It is apparent that this plan falls somewhat short of what will be required, in having no more depth throughout the Canal and basins than over the sills, and having the lock chambers too short, considering that, as already said, we now have lake vessels little short of 300 feet in length. The body of the Canal and its basins should have their water at least 12 inches deeper than over the sills.

Colonel Blunt's plan also contemplates, where there is rock, that the width shall be 100 feet and sides vertical, and in clay 90 feet wide at bottom and 125 feet at the water surface. These dimensions are well chosen and cannot be improved. His estimate of the cost of the whole construction is $12,095,438.

To modify this plan — preserving, however, the same number of locks with the same lifts, but making the chambers 350 × 50 feet, with 16 feet water on the sills and 17 feet depth in the

Canal and basins — will augment his estimate by $1,361,821 upon the same prices as he used, which would make the total cost of this modified plan amount to $13,457,259. Hereafter I shall call this Colonel Blunt's plan modified. Should the Canal not be built upon this larger scale, it will be a source of deep regret ever after. The locks would be none too long for the largest class of vessels, nor the water too deep in times of variation of the water stages, which must be expected to occur from time to time, as they have been known to do for all past time.

Colonel Blunt says in his report: "I have not felt myself at liberty to consider anything but well known systems and plans of canal construction. * * Certain projects for an inclined plane, and for a single lock, or well, to overcome the whole descent at once, have been laid before me; but I have not had time, had I felt it my duty, to investigate them thoroughly, and cannot take the responsibility of expressing my professional opinion upon them."

The great engineering problem of passing ships around the Niagara Falls, is of too much importance to the future commerce of our country to omit candid considerations of every reasonable project that may be offered.

In this place, therefore, I take occasion to bring to notice some plans other than the "well known" one just considered, and which have been submitted to me for criticism.

The plan of John Burt, Esq., is to make the Canal from Schlosser on the same route as proposed by Colonel Blunt, to a point A (see profile), which is within about 1,100 feet of the very brow of the mountain; then to turn a little so as to descend the mountain more directly to the lower terminus; and between the point A and the brow to put in a single lock of 316 feet lift, and thus overcome the entire lockage at once. The chamber of this lock to be 100×400 feet, and excavated with sides vertical down through the top clay and all the underlying rock strata to a depth of 16 feet below the surface of the river. From the end of this chamber which is towards the river, a tunnel is to be excavated in the rock, for a part of the vessel passage, between the chamber and the river: the bottom of the tunnel to be on a level with the bottom of the lock chamber; and the width of the tunnel to be 50 feet, and its height from the bottom to the crown of the arch to be 150 feet, or as much less as will allow vessels with their masts to pass safely through. The length of the tunnel (between the lock and the face of the bluff) will be nearly 1,109 feet. From the face of the bluff where the tunnel emerges into open air to the river will be 1,549 feet; this part to be a thorough cut in the rock open to the sky, and to be continued under the river to a distance from the shore where the water is found of sufficient depth for vessels. A vessel leaving the river to ascend first passes through the "thorough cut" for an extent of 1,549 feet; thence through the "tunnel" for an extent of 1,109 feet; thence into the lock chamber. At the lower end of this chamber there is to be a foot gate made of steel, wide and high enough to close the whole head of the tunnel opening. This gate is not to swing, but to slide easily up and down, having counterpoises like a window. Just above the chamber in the Canal proper there is to be a head gate of steel or iron. The head gate being closed, the ascending vessel in the chamber, the foot gate is closed. Now the water from the upper level is to be let into the lock by 50 iron tubes of two feet calibre, extending from just back of the head gate down the breast wall of the chamber and along the bottom of the chamber. In the horizontal bed parts of these tubes there are to be orifices allowing several hundred jets of water to issue upwards, lifting the vessel by their upward efforts, distributed and applied equally on its bottom through the intervention of the "prism of flotation," and thus to lift the vessel and cargo 316 feet vertically to the upper level, with the great advantage of not surging the vessel against the sides of this chamber, and thereby saving it from the damage usually experienced in letting the water in by sluices or wickets. The vessel being raised the head gate is opened, and the vessel passes on its way up through the Canal.

The filling and emptying of the lock through the tubes are regulated and controlled at pleasure by a highly ingenious system of rotary valves of Mr. Burt's invention. The inlet valves are applied to the parts of the tubes back of the head gate, and the outlet valves to those parts of the bed tubes which are just below the foot gate. And he is perfectly satisfied that he has perfected the arrangement and manner of working these valves with ease, security, and success for rapidly filling and discharging the chamber.

Of course it is very readily seen that the practical success of his plan must depend materially upon the working of his rotary valves. Having described all the essential features of his design, also the process of passing a vessel *up*, it is easy to understand how one is to be passed *down*. The lock being empty, except of its prism of flotation, both gates and the escape valves are closed, the inlet valves are opened, and through these the chamber is filled. The head gate is then opened, and the descending vessel passed into the chamber. The head gate and inlet valves are now closed, and the escape valves are opened, through which the prism of lift runs down, lowering the vessel as the chamber empties; the foot gate is then raised and the vessel passed on through the "Tunnel" and "Thorough Cut" into the river below.

It is thus seen that the principle upon which the water itself is made to do the lifting and lowering is the same as in the ordinary lock.

A few words here must suffice in respect to Mr. Burt's Mammoth Steel Foot Gate of 50 feet width by 150 feet height. This undoubtedly can be constructed with as much nicety and all sufficient strength, and to move in its grooves with ease and more perfect tightness than a wooden gate. It would require besides its counterpoises, only sufficient force to overcome the friction at the pulley journals to slide it up and down. It would not be moved except when the resultant of the pressures of the water against it would be zero, for, when lowered or raised, it would only be in the prism of flotation, pressing it equally on both sides.

When closed and chamber filled, the water would force the gate against all its bearings, with a resultant pressure of 58,708 tons, tending to tighten the gate against its bearings. Take two strips of 12 inches in height of the gate — one being down just above the prism of flotation, where the strain would be greatest, and the other just below the arch of the tunnel — the pressure on every square foot of the first would be $9\frac{86}{100}$ tons, and upon the second $6\frac{50}{100}$ tons. The strain upon the lower strip could be assimilated to that upon a beam 50 feet long fixed against a thrust at both ends, having 12 inches for the breadth of its cross-setcion, and being loaded with 493 tons uniformly distributed. It would be upon these data that Mr. Burt would have to compute the thickness of his steel gate. When its shape and thickness are computed, to most effectually resist the pressure, its weight will result, also the weight of its counterpoises; then the friction upon the journals of the pulleys could be estimated. Until we ascertain how much extra force would be necessary to overcome this friction, and whether it would require a steam engine or a water-power derived from the great head of fluid in the lock, to move the gate, it is difficult to decide upon the merit of this particular point of the plan without more study than I have devoted to it.

The counterpoises can be arranged with simplicity and security against accidents.

This lock is intended to pass, if required, six vessels at once. This capacity, and all the lockage being concentrated in one lift, are good features in the plan. The route selected is especially adapted to the execution of the design, and there are no engineering difficulties in the way: nature having furnished, as we all know, an unlimited supply of water to feed the chamber from the upper level; also, a bold rock bluff projecting out so near the river in which the "Chamber," "Tunnel," and "Thorough Cut" would be made in strata shown by a geological survey [see the geological profile] to be well suited to construction and permanency.

Mr. Burt estimates the cost of the whole work upon his method at $9,256,376, which is less by $2,743,624 than Colonel Blunt's plan upon the same route and depth of 14 feet. But to have 17 feet in the Canal and 16 feet on the sill, Mr. Burt's plan must cost at least $11,500,000. This is less than the estimate for Colonel Blunt's plan modified by $1,957,259.

Mr. Burt claims that his one lock will be more permanent and safer for passing vessels, requiring less repair, than 21 double locks, and safer from an enemy's attack; that it will cost much less for the working of the Canal, his lock requiring only 8, while the 21 double locks would require 200, men in attendance. These are points well taken, and apply with great force to the question.

He also claims that his plan would pass vessels with greater dispatch; that his "mammoth" lock would pass one or six vessels in 40 minutes; while Colonel Blunt's plan would require 8 to 10 hours; and that his lock could pass 216 vessels in 24 hours, while Colonel Blunt's flights could pass only 144 in the same time."

If there could always be six vessels at a time to pass, probably he would be right in his opinion upon this point. But suppose only one to present itself, claiming no delay for others to arrive?

Dispatch is an element of great importance, and should have much weight in the problem of construction of the locks for this Canal. It is a question to be settled by the application of well-known mathematical formulas, as soon as the number and diametres of the orifices and structure of the apertures of his valves are given. It is easy to perceive that the times of filling and emptying the chamber of his lock could be diminished very materially, almost *ad libitum*, simply by assigning proper shapes and larger *diametres* to the tubes at the inlet, and to the apertures of the valves, and to the orifices in the bed tubes.

Inasmuch as the supply is inexhaustible, the relative consumption of water necessary for working the locks, whether upon Colonel Blunt's or Mr. Burt's plan, is of no consequence, except in respect to the *time* of filling and emptying the chambers.

By making the apertures of the 50 inlet and outlet valves in Burt's in the shape of the "vena contracta," and 24 inches *diametre* of smallest section of the vein, and placing the former 20 feet, which is a convenient distance, below the upper water level, I find the time for filling would be $32\frac{54}{100}$ minutes, and for emptying $19\frac{32}{100}$ minutes. Hence, an *ascending* vessel, arriving when the lock is empty, could be passed in 35 minutes, and arriving when the lock is full it could be passed in 55 minutes, and a *descending* vessel, arriving when the lock is empty, could be passed in 55 minutes, and arriving when the lock is full it could be passed in 22 minutes. A double lock upon Mr. Burt's plan would relieve the Canal, in a measure, from the detention to navigation, while making repairs, should one lock get out of order. In this respect, and with a view to future increase of commerce, the question might be asked: Would it not be better to make a double lock upon his plan, with chambers about 60×400 feet, than a single one of 100×400 feet chamber? Before adopting, however, such deep chambers, there is another circumstance not yet touched upon, which should not be overlooked, and which has reference to the seams and fissures in the rock strata in which they would be made. The geological profile presented shows eight strata of different kinds of rock, down through which the chamber would be excavated, and the upper level of the Canal is to be excavated in the top stratum. Suppose seams and fissures should allow the water in the upper level to find its way around or under into the chamber? In such a contingency there might result many little cascades spouting into the chamber, sufficient to produce inconvenience to the vessel and cargo while being raised or lowered in the lock. It would not be difficult to remedy this by proper engineering.

The rushing in of water through the fifty tubes, with a head at the start of not less than 17 or 20 feet, would probably produce so smart a current in the canal above as would interfere with easy and safe progress of vessels which might be passing to and fro therein while the lock would be filling. To obviate this and to give room for waiting vessels, a large basin, say 200×400 feet, with 17 feet depth of water, should be constructed a short distance above the mammoth lock. Indeed a basin should be made there for any plan of locks.

In passing, I may say that I am very confident Burt's method of letting the water in and out by tubes could be applied to the ordinary lock with advantage, to prevent the usual surging and pitching of the vessel while filling the chamber; and I would express the hope that his magnificent project will receive the careful consideration of canal engineers, to the end of fully and fairly developing all its merits or demerits before adopting or rejecting it. It certainly is easy of application on this particular route. In its working, the force of the water itself, of which there is a vast amount now being wasted, would be the moving power, requiring no expensive extraneous stationary power to lift or lower the vessel with its cargo. In this respect, therefore, it is immeasurably superior to an inclined plane attached to the lower end of the Canal, as proposed by Horace Day, Esq.; or to a marine railway all the way, with an inclined plane at each extremity, advocated by several civil engineers some years since, and whose opinions Mr. Day circulated in a pamphlet, and used in his strenuous advocacy of the inclined plane part of the marine railway project being applied, in preference to locks, to the Lewiston end of a Canal, for overcoming the 316 feet fall by using stationary power; or, as good luck might bring two vessels from opposite directions simultaneously, causing the descending to haul up the ascending one—each carried in a tight dock containing water for the vessels to safely ride in, the docks being moved on 1,800 rollers fixed in the plane of 2½ miles in extent, and connected by a cable that long, going around a windlass at the top of the plane, and a canal constructed for the remainder of the passage around the Falls. The demerits of this plan were so fully pointed out in a former communication that it is unnecessary here to present them for reconsideration, being satisfied that full justice was then done to Mr. Day's project.

But there is another plan not yet touched upon which has recently been presented, emanating from one of high standing and too much experience to be omitted in this memoir.

It is the plan of Caleb Forshey, Civil Engineer, devised for the Lewiston end of the Canal, and designed to overcome the total fall at once without a lift lock, and yet relying on the weight of water for lifting and lowering the vessel and cargo. (See drawing of the section.)

The plan consists of two parallel thorough cut canals, with sides vertical and smooth, extending from the river 80 feet wide, and water deeper in them than 17 feet (by a quantity x, which may be calculated). These cuts to penetrate the rock formation into the mountain brow 2,680 feet horizontal distance from the water's edge. At the stopping place in the brow of these deep cuts, their breasts from their very bottoms are to be made also vertical and smooth as high up as 299 feet above the river's surface; thence the thorough cuts are to be continued 600 feet, with their bottoms, however, only at the same level as the tops of the breast heights, and terminate in an upper basin of the size of 400×600 feet on top of the mountain, and having 17 feet depth of water. From the upper basin to Schlosser, the Canal to be single, with 17 feet of water, with dimensions in width, guard lock and harbor at Schlosser as in the proposed modification of Colonel Blunt's and Mr. Burt's plans for this part of the line.

The pier or prism of rock left between the two branches of the bifurcated part of the Canal is to be about 80 feet thick, and its rock top, also the rock top on either side of the branches, are to be brought to level and firm benches at the same height. These benches commence a little above and extend about 350 feet below the breast heights; and the inner corners of the benches are to be plated with thick iron if the rock should not prove sufficiently strong without it.

In each canal branch just above the breast height there is to be a tail gate, not in mitre shape but straight across, with two leaves opening by swinging inwards, and when shut bearing against a straight sill at bottom, allowing 16 feet of water over it. This gate when shut is to be fastened by iron hooks.

There are two large docks to be constructed of iron, into which water is to be put to float the vessel and cargo in. Each dock is to have two gates—one at each end—also straight across, opening inwards, and bearing when closed against a bottom sill, and fastened by iron hooks.

Wire ropes, having their ends firmly anchored into the tops of the benches of the outer sides of the canal branches, and passing down these sides under the dock bottoms, thence continued up the inner sides of the canal branches, and over high, strong pulleys fixed upon the pier bench, are to suspend and carry the docks in their vertical motion alternately up and down as may be required—one dock always going up as the other goes down, each carrying its passing vessel or vessels. To enable the system to move up and down with precision, safety, ease, and diminished friction, small pulleys with deep grooves are to be firmly set in the sides of the canals; also in the bottoms of the docks; and the suspending ropes are to render in the grooves.

The ends of the canals at the tail gates, and the ends of the docks which come up there, are to be furnished with ample India rubber "buffers," so that when the dock-ends come fairly up they shall lay water-tight or nearly so, on being fastened with hooks to the ends of the canals; and thus, when the tail gate and dock gate are opened, the dock may, to all intents and purposes, be a part or prolongation of the canal branch; and a vessel with its cargo can float over the sills from the Canal into the dock, or *vice versa.*

Having given a description of all the essential parts of the Forshey plan, it remains to give his explanation of its practical working for passing vessels.

One dock being joined end to end with and hooked to its corresponding upper canal, the other dock, of course, will be down in its corresponding lower canal, from which the vessel to be lifted enters this dock, whose gates are now closed and hooked. Then the water is let through wicket gates (set in the tail and lock gates) into the upper dock from the Canal until filled to the same level as in the Canal, the buffers preventing undue leakage. Then the tail and lock gates are opened, and the descending vessel (if there be one at hand), will be floated into the dock and all the gates shut.

It is a part of the plan that by exact gauge marks fixed in both docks it can always be readily told when the docks are properly freighted; and when the adjustments are such that an equilibrium exists between the weight which is to descend and that which is to ascend, by adding more water to the upper dock it will begin to descend, and in a very short time rest in the water of its lower canal; and the other dock will be found lifted, with its vessel, to the tail gate of its corresponding upper canal, where it is to be secured by the hooks; and being water-tight at the buffers, the wicket gates on being opened will allow the vacant space between the tail and lock gates to be filled, and the water in the canal and lock to come to the same level. Then these gates and that of the descended dock will be opened and the vessels removed from both docks and allowed to proceed on their respective ways, and the docks ready to receive other vessels.

Sometimes two or more vessels will be made to enter one dock to counterpoise one or more in the operation of lifting and lowering.

In case no vessel be ready to counterpoise one seeking to pass either way, the balance will be effected by water only in the dock which has no vessel; and in all cases the balancing, adjusting and moving required will be effected by water.

For the purpose of regulating the rate of movement, for starting and stopping at pleasure, also for working pumps for adding or subtracting water to perfect the adjustments of the docks and to move the system, the plan contemplates the use of a steam engine.

Such is the method of Colonel Forshey. Now, I estimate that both locks, with their loads of two of the largest freighted ships passing — one up and the other down — would weigh not less than 19,972 tons, and this would be the weight to be sustained by the ropes.

Each rope would be 1,030 feet long; and, supposing it 6 inches in circumference and made of iron wire, it would weigh $2\frac{6}{10}$ tons, and it would require 126 such and as many top pulleys to sustain the loaded docks, including the weights of the ropes. The pressure upon the journals of each pulley would be $81\frac{2}{3}$ tons. There are other forces besides to contend with in the movement, viz: friction, rigidity, and the additional weight of water put into the dock to move the system. The effect of all the foregoing forces constantly acting would be to stretch the ropes.

Again, notwithstanding all the regulation of motion that may possibly be effected by the steam engine, the moving mass would be liable to shocks exerting a percussive force upon the ropes, tending to snap them asunder, like a hawser broken under the jerk of a vessel.

It seems to me there would be a liability, though they might not break, of the ropes stretching so much under the constant action of such heavy forces, that when the dock comes up to the upper Canal, the sill of its gate and that of the tail gate might not be on the same level. The variation in the height of the lock sill by the expansion of the ropes from freezing temperature to the highest summer's heat, would be appreciable. To bring the lock sill flush up to the canal sill, would require, on account of these causes, during the season of navigation, a continual vexatious readjustment of the lengths of the ropes, and there would be difficulty of no small magnitude in hooking the ends of the dock and Canal together, and of preserving sufficient tightness at the buffers.

As soon as the descending dock begins to move there is a growing preponderance in its favor, arising from the weight of increasing amount of rope on its side, causing an accelerated motion which it would be unsafe to check and difficult to regulate by the engine.

Another circumstance is that where the descending dock immerses in the water of the lower canal, an oscillation or bouncing cannot be prevented so effectually by any application of the regulating engine as to avoid jerking the ropes, if not entirely out of the pulley-grooves, still so strongly against their sides or edges as soon to chafe the ropes to pieces. Should they be thrown out of place or become "foul" down under the dock in that water, serious detention would occur; and this liability would be produced by another cause, which is, that in the river at Lewiston there is sometimes a considerable swell from the northerly winds, which would be communicated to the lower bifurcated canal and so agitate the dock there as to jerk hard upon the ropes. This effect might, however, be avoided in a measure by putting in guard gates; but if they were put in they would have to be opened many times when that wind would be blowing.

Again. Under the most favorable circumstances, where ropes are used over fixed pulleys and against fixed points like those in this plan, with heavy action upon them, they soon wear out. Oxydation, too, of the journals of the top and all other pulleys in the plan, and of the ropes themselves, is a cause of deterioration difficult to contend with. The renewal of the ropes and pulleys would be a heavy item of expense to be often incurred.

To sustain a pressure of 81⅝ tons, the journals of every top pulley would have to be large, and the friction would be in proportion not only to this large pressure, but its opposing effect would be proportional to the diameters of the journals.

In the motions of the docks up and down, vessels floating in them with their heavy top-masts, spars and rigging, would careen and pitch. Drafts of wind, even, rushing through the thorough cuts would give tendency to oscillation of the suspended masses, and the docks would be liable to hit against the walls. To prevent this, possibly, rollers might be intervened or buffers put upon the sides of the docks; and it may be asked, what master of a vessel would have confidence in the safety of his vessel seeing it suspended more than 300 feet high in mid air?

The foregoing circumstances are so many practical difficulties in the way of successfully working this ingenious plan, and must be provided for before one would be justified in adopting it.

I think its first cost, which would probably be about $12,000,000, and the expense consequent upon wear and tear, would make this plan in the end a more expensive one than the plan of Mr. Burt or that of Colonel Blunt, to say nothing of the much greater risk and want of confidence in its use.

Its author claims much expedition for the passage of vessels by it. There are so many adjustments and other circumstances to attend to, requiring time, and above all, so many different kinds of forces complicated in its working, that it is very difficult to come to a definite opinion as to the time it would consume to make a given number of passages of vessels by this method.

Before dismissing the question of overcoming all the fall brought between the mountain brow and the Lewiston terminus on this short route, there is one more plan presented for the consideration of engineers, and which consists in making two thorough parallel cuts commencing at the river's edge, following Burt's route, and penetrating 4,645 feet horizontally into the mountain brow: these cuts, however, not to be at the full depth all the way, as in Burt's or Forshey's plans, but to rise in steps. The first step, which is that next the river, to be 410 feet long and 17 feet deep below the river's surface; the next step to have its tread at the same level as the river's surface, and to be 385 feet long and rise 26⅛ feet; also all the other steps 385 feet long and 26⅛ feet rise as we ascend. There would be 12 steps and the same number of risers in each thorough cut.

On these steps, between the vertical rock sides of the cuts, this plan proposes to arrange a flight of 12 double locks, each with a lift of 26⅛ feet, and chamber 50 × 350 feet, having 16 feet of water over the sills. The excavations into the river from the tails of the lower locks not to be bifurcated, but to be of the whole width between the outer faces of the two cuts, and to have 17 feet depth of water everywhere in it. This, with the river, would form the lower basin. The upper locks in the double flight would come about where Colonel Blunt's 19th lock would come in his short Lewiston route.

More than 30 years since locks were constructed in our country with 25 feet lift with wooden gates, and worked well; and at a later period iron gates have been constructed for prisms of 30 feet lift, and have worked successfully.

It would be best to make the gates of steel, and swinging with two leaves; and the question would arise whether it would not also be best to put in the tubes on Mr. Burt's ingenious plan for filling and emptying the chambers, if practicable in so long a flight.

On top of the mountain, some 600 feet from the upper locks towards Schlosser, and where the excavation would only be 30 feet deep, would be the place to make the upper basin, 15 feet of the excavation for which would be in the top clay, and 15 feet in the under rock. Nature presents here the most befitting place for an upper basin, which, as already said, should form a feature in the Canal, whatever plan may be adopted. From the head of the flight to this basin the Canal should be bifurcated, as in Forshey's plan.

In regard to the widths of the thorough cuts, in which the locks are to be placed, and the thickness of the rock prism left between them, they must depend in some measure upon the compactness of the rock strata. The geological survey presented by Mr. Burt shows that we may rely with some hope upon using the very rock itself by making smooth work for the faces of the lock chambers and breast heights of the lifts. This being supposed, the cuts would be 50 feet wide and the prism partition say 20 feet thick.

The cost of the whole work upon this plan of locks and basins for the same width of Canal as proposed by Colonel Blunt, but of 17 feet water in the Canal and 16 feet on the mitre sills, will, by an approximate estimate, amount to $12,500,000.

The time for passing twelve such locks would be considerably less than for passing 21 chambers, as in Colonel Blunt's plan, though the time by these twelve locks would undoubtedly be greater than by Burt's lock. Taking a whole year's commerce of large and small vessels, his lock would show a greater saving of time over every other plan suggested, if we suppose it no more liable to accident, or disaster causing no greater delay for the remedy than the other plans.

What precedes, upon the question of passing the Falls by a Canal on the American side, applies only to the shortest recog nized practicable line known as the Lewiston route, and which lies nearest the Niagara River frontier. The river where the debouch of the Canal would be is only half a mile wide.

Several other routes were surveyed and estimated upon by Colonel Blunt. One of these is called the "Eighteen Mile Creek Route," about 25¼ miles long, leaving Niagara River at Tonawanda Island, 8¼ miles above Schlosser, going round by Lockport, N. Y., thence debouching into Lake Ontario at Olcott Harbor, which is at the mouth of this Creek—making the total lockage 320¼ feet.

However well put these points seem to be, those who advo cate the shortest Lewiston route meet them by the following: Admit that 15 miles of river and lake, adapted by nature for all sizes of vessels, is avoided, nevertheless this route being longer by more than 18 miles of canal-towing, with a little more lockage than the Lewiston route, the question arises: Will 18 miles of canal-towing take less time for the passage of ships than 15 miles of good river and lake navigation? Should the additional length of Canal consume more time, the argument, in its application to commerce, would seem to be in favor of the Lewiston route.

As to security from attack, the Lewiston route requires the whole work to be excavated, first down into a stratum of stiff clay, which would have to be wasted, and could be formed into a thick parapet on either side; then the excavation is down in rock for a depth considerably deeper than the depth of the water in the Canal. This spare rock will form an immensely thick revetment to the clay parapets. The work being thus covered and incased in rock, it would be very difficult for a secret party to do damage; nor could a battery on the Canada side work serious injury, unless put in the prolongation of the line of the locks. On this prolongation an enemy's battery could probably be erected within three-fourths of a mile, and if unmolested enfilade the locks. But that position, as all others for an enemy's battery, could be completely commanded by guns properly posted behind or on the canal and lock parapets. By wasting the materials excavated therefore, with a view to defense, the Canal in itself would be a formidable fortification, which, if well armed and well served, would defend from any serious injury. Besides, Fort Niagara is only seven miles below. The greatest injury that could be done from an enemy's battery would be to vessels passing up and down the river. But even these ought to be protected by our own batteries. Of course, whichever route may be adopted, it would be necessary in time of war with our opposite neighbors, to protect the work with a force sufficient to guard it from surprise and all injury. But before this Canal will be constructed political relations will probably be such between the Dominion and the States that no military protection will be needed.

It should not be forgotten, that for a Canal on any route around these Falls, a tug would be necessary for towing vessels into and through it, and probably there would be no more, if as much, tug force required for the Lewiston as for the Olcott route.

5th. After passing Lewiston, no obstructions exist in the natural ship navigation all through Lake Ontario and down the St. Lawrence River, until we reach Galop's Rapids, whose summit is 272 miles below Lewiston. At the head of these rapids we come to a reach of about 106 miles, extending to Montreal, in which reach of the St. Lawrence obstructions to safe ship navigation occur in seven places in the character of rapids, which, however, are separated by pools of various lengths, in which the navigation is good for ships. Passenger steamers jump these rapids. Around the rapids Canadian Canals have been constructed, as here tabulated:

NAME OF CANAL OR RAPIDS.	*Lockage in feet.*	*Length of Canal, Miles.*	*No. of Locks.*	*Lift of Locks in feet.*
Galop's....................	9	2	2	4.5 av
Connecting Link Canal,.......	0	2⅝	0	0
Point Iroquois,..............	6.75	3	1	6.75
Platte,......................	11.5	4	2	5.75 av
Farren's Point,..............	4.	¾	1	4
Cornwall,....................	48.	11½	7	6.86 av
Beauharnois,.................	82.5	11¼	9	9.16 av
Lachine,.....................	44.75	8½	5	8.95 av
	206.5	43⅝	27	

Each lock has its chamber 45×200 feet, and only 9 feet water on its sills. These are called the "St. Lawrence Canals." They allow the passage of vessels 186 feet long, and 43 feet beam, maximum burthen 300 tons, equivalent only to 10,000 bushels of wheat.

The cost of enlarging these canals to locks of 46×350 feet in the chamber, 16 feet water on the sills and 17 feet everywhere else in them, would probably amount to $5,200,000. From Montreal to Three Rivers — up to which tide water comes — it is 90 miles, in which ships drawing 20 feet safely navigate. The total fall, or difference of level, from the foot of Lake Ontario to tide water at Three Rivers is about 235 feet. The difference between this and the total lockage of the St. Lawrence Canals is 28½ feet. This is due to the natural inclination of the river for all those parts in which there are no rapids. In these parts, on an average, the fall is nearly $1\frac{6}{10}$ inches to the mile.

From the head of tide water at Three Rivers out to the Gulf of St. Lawrence, it is 500 miles, in which ice in winter is the only obstacle to ship navigation. In this respect, the Puget Sound waters of the Pacific have the advantage, offering no obstruction, in any season, to the freedom and safety of ships navigating them.

III. EXTENTS AND COSTS OF IMPROVEMENT OF THE DIFFERENT KINDS OF TRANSPORTATION.

Having described all the obstructions and methods of improving them, from tide water of the Pacific to that of the Atlantic, on this natural northern line of inter-oceanic commerce, I present the distances on the track of transportation as follows:

DESIGNATION AND KIND OF TRANSPORTATION,	Length of track of the kind of transportat'n in miles.
Projected Northern Pacific Railroad,...........................	1775
Ship navigation in Lakes Superior (410 miles); Huron (235 m.); St. Clair (22 m.); Erie (240 m.); Ontario (180 m.).,.........	1087
Ship navigation in rivers connecting these lakes, and where no improvement has been made: St. Mary's (45 miles); St. Clair (30 m.); Detroit (35 m.); Niagara (25 m) St. Lawrence, (218 m.),........	353
Ship navigation by canals, constructed and contemplated, to overcome obstructed places in these rivers: Saut de Ste. Marie (1 mile), constructed; St. Clair Flats (1¼ m.), nearly completed; Niagara Falls (7 m.), proposed, not commenced; St. Lawrence Canals (in all 43⅝ m.), constructed,...............	53
Total distance from tide water to tide water.............	3268

We therefore see that on this route we should have 1,775 miles of railroad and 1,513 miles of ship transportation between tide water of the Pacific, at Seattle, on Puget Sound, and tide water of the Atlantic, at Three Rivers, on the St. Lawrence.

The amounts of money required for the contemplated improvements, to the largest scale, are tabulated as follows:

DESIGNATION OF EACH IMPROVEMENT.	Dol'rs requir'd.
First, construction N. P. R. R., 1,775 miles, single track, equipments, sidings, and buildings, $46,283 per mile, in coin,...	$82,152,325
Harbor and necessary docks at head of Lake Superior,........	1,000,000
Improving Saut de St. Marie Canal,..........................	250,000
Improving other places in this river,........................	149,021
Finishing St. Clair Flats Canal $15,000, and to deepen it to 17 feet, $30,000, ...	45,000
Construction of *Ship Canal around Niagara Falls, on Lewiston shortest route,..	13,457,259
Enlarging the St. Lawrence Canals,..........................	5,200,000
Total costs,..	$102,253,605

*The estimate for this Canal would, of course, be somewhat modified, according to the plan which would be adopted.

It will be seen that for all, except the railroad, the improvements, including a harbor and docks at the head of Lake Superior, will cost $20,101,280. This supposes the canals to be brought to a depth of 17 feet, the lock chambers to the size of 350 feet in length, 46 to 50 feet in width, and 16 feet depth of water on the mitre sills, requiring $15,601,280, to be expended on works in the United States, and $4,500,000 on those in the Dominion of Canada.

IV. TIME OF MOVING HEAVY FREIGHT FROM SEATTLE TO THREE RIVERS.

Supposing all the foregoing improvements completed, the approximate time for the movement is estimated as follows:

	Days.	Hrs.
From Puget Sound to Lake Superior, by rail,..................	6	2
On lakes, including one day for trans-shipment at Lake Superior from cars into vessels,..................................	6	15
On rivers connecting the lakes,..................................	1	20
On canals, where obstructions are in the rivers,................	1	3
To pass through all the locks,..................................	1	3
Total,..	16	19

V. COST OF TRANSPORTING FROM SEATTLE (TIDE WATER) ON PUGET SOUND) TO THREE RIVERS (TIDE WATER IN THE ST. LAWRENCE), SUPPOSING ALL THE IMPROVEMENTS PERFECTED.

Hon. W. J. McAlpine, in his comparison of the costs of freighting by different modes of conveyance, puts them as follows:

By Railroad,..........................	12½ to 13½	mills per ton per mile				
By Lakes,..........................	2 to 3 and 4	"	"	"		
By Rivers,..........................	2½ to 3	"	"	"		
By Canals,..........................	4 to 5	"	"	"		

The highest numbers being applicable to short, and the lowest to long lines of conveyance. On the route we are considering, all but the canals are long lines. By applying the foregoing costs to our table of distances we shall find the costs from—

Seattle to Lake Superior, by rail,	$22 19	per ton
Lake Superior to Three Rivers, by ship,	3 33	"
From tide to tide, total	$25 52	per ton

At present it costs $9.25 per ton from Lake Superior, *via* the Erie Canal, to the seaboard, or to Atlantic tide water.

VI. QUESTIONS PUT AS OBJECTIONS AND ANSWERED.

Suppose the Canal around the Falls constructed, how are your large vessels to reach the Atlantic while you have neither the free navigation of the St. Lawrence below St. Regis, nor the right to enlarge the St. Lawrence Canals so as to allow your large freighting vessels to pass through?

Now, this objection is often put; but it is no argument against the construction of the Canal around the Niagara Falls, as I will endeavor to show.

Unobstructed navigation extends on the St. Lawrence down our own border 65 miles below Lake Ontario, and nearer to Eastern markets by nearly 300 miles than our large upper lake vessels are permitted to reach by the single obstruction of the Niagara Falls.

Construct the seven miles Canal around these Falls, and there will at once be added nearly 300 miles of ship navigation to what we now have for a population of twelve millions of producers in eight Lake States, whose produce in 1867, in breadstuffs alone, amounted to 257,700,000 bushels of wheat, and 269,700,000 bushels of Indian corn. Were I to ennumerate other products of the farm, and products of the forests, and of the mines, there would be adduced results in amounts proportionate to these breadstuffs, all of which go on augmenting from year to year.

On our own shore of Lake Ontario and bank of the St. Lawrence, there are eight commercial ports, at which there are railroads and at least one canal terminating and connecting in

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every direction with New England and New York lines of transportation.

Extend the large ship navigation from the upper lakes to these ports, and the surplus produce of the lake States, and that which is soon to come pouring in from the Northwest, will be carried to eight more distributing ports 300 miles nearer the points of consumption, instead of being, as now, all distributed from only one port, and conveyed by only two lines, which are inadequate to carry the surplus, and what is carried upon them is too expensively conveyed by round about paths before reaching the doors of the consumers, in all New England and Northern New York. And the same argument will apply, with equal force, in respect to the return commodities required by the Lake States and the Northwest, to come by shipping from the Eastern States *via* the Ontario ports.

In this enlarged facility of interchange of commodities lies the blessing a Canal on our side of the Falls would confer upon the Lake States, the Northwest, and all New England, though our large ships should not be permitted to pass below Ogdensburgh or St. Regis, on the St. Lawrence. But let such vessels heavily freighted with grain, lumber, timber, iron, and copper freely enter into Lake Ontario, and it is morally certain that not only would the St. Lawrence Canals be immediately enlarged, but competition would force the enlargement of the Erie and Oswego Canals to dimensions suitable for lively participation in the transmission of heavy freight, and then all obstacles causing the breaking of cargo would be removed, that now block the passage from all the lakes directly to our seaports, or to those on foreign coasts, for vessels large enough to cheapen freights down to a minimum.

One more objection raised to this Northern route is that "It is frozen up half the year." This is an exaggeration of the time. It is admitted that generally the rivers connecting the lakes are closed or clogged with floating ice from December 10th to April 10th, that is, for four months in the year. And so it is on the Mississippi above the mouth of the Ohio; on the Missouri; on the Illinois; also on the Illinois Canal; and for three months in the summer season, the low water in these channels is a very great impediment to cheap transportation. The objection of low water does not apply to the Northern route.

As a general rule, the St. Lawrence Canals and that river are open for navigation 240 days in the year. Ocean steamers arrive at Quebec as early as May 1st, and depart as late as November 24th.

There is ample time after ripening for all the grains to be harvested, prepared, and sent from all the Lake States and the Northwest to the lake ports, and shipped down the lakes into the St. Lawrence, and thence across the Atlantic, even before navigation closes on this route.

For all edible products shipped to the seaboard and thence to foreign ports, the Southern route, *via* New Orleans, with the Upper Mississippi improved ever so much, cannot favorably compare with the Northern, on account of the deteriorating effect of so warm a climate upon such products. The deterioration has been estimated at 5 per cent. disadvantage on the Southern voyage.

In drawing this comparison between the Northern and Southern routes, by which products may be made to reach foreign markets, it is very far from my intention, nor is it to the interest of the public, to decry one route with a view of building up another. On the contrary, it is my aim to give each its just due, and with the hope that both of these lines shall yet be improved by well digested plans of engineering to capacities altogether commensurate with the growth of our Lake and Northwest States.

All of which is respectfully submitted by

THOS. J. CRAM.

To the Board of Trade of the City of Detroit, Mich., December 24th, 1869.